MARSHALL DAY Acoustics

RYMAN KOHIMARAMA CONSTRUCTION NOISE AND VIBRATION MANAGEMENT PLAN

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1.0 INTRODUCTION

Marshall Day Acoustics (MDA) has been engaged by Mitchell Dayse, on behalf of Ryman Healthcare, to prepare a Construction Noise and Vibration Management Plan (CNVMP) for the construction of a new Comprehensive Care Retirement Village.

This CNVMP is required to satisfy Consent Condition Y. It identifies the performance standards for the Project and sets out best practicable options (BPO) for noise and vibration management.

This CNVMP should be implemented throughout the construction period. It should be considered a 'living document' that is expanded and updated as the Project progresses and working conditions become clearer. It is intended to be the primary tool to manage the Project's construction noise and vibration effects.

A glossary of terminology is included in Appendix A.

2.0 PROJECT DESCRIPTION

2.1 Overview

The works involve construction of a new comprehensive care retirement village at 223 Kohimarama Road and 7 John Rymer Place (**Site**). It has been designed to fit within the existing topography of the site and would include a park.

Site maps identifying layout of the Site and nearby receivers are attached in Appendix B.

The works are scheduled for approximately 32 – 42 months, between [month year] and [month year].

Construction hours will be 0700 – 1800 hrs, Monday to Saturday.

2.2 Construction Methodology

The construction methodology for this Project is summarised as follows:

Table 1: Proposed construction programme

Stage	Activity	Hours of Operation	Approximate Duration (weeks)	Estimated no. of Truck Movements per Hour
1	Initial site works	0700 – 1800 hrs	4 weeks	2
2	Earthworks / removal of existing buildings	0700 – 1800 hrs	3 seasons (30 weeks each)	6 – 8
3	Construction and Fitting out	0700 – 1800 hrs	Staged over 156 weeks	18 – 34
4	Vehicle Crossings	0700 – 1800 hrs	6 weeks	12 – 26

2.3 Contact Details

Contact details for the relevant personnel are included in Table 2. The Project Manager is ultimately responsible for implementing this CNVMP.

Table 2: Contacts

Role	Name	Organisation	Phone	Email
Project Manager	TBC	TBC	TBC	TBC
Acoustic Specialist	TBC	TBC	TBC	TBC
Public Complaints	TBC	TBC	TBC	TBC

3.0 PERFORMANCE STANDARDS

3.1 Noise

Construction noise must be measured and assessed in accordance with the provisions of New Zealand Standard NZS 6803:1999 "*Acoustics - Construction Noise*". The noise limits apply at 1m from external façades of occupied buildings.

The relevant construction noise limits from [Condition X (refer Section X), NZS6803:1999 or AUP Rule E25.6.27] are summarised in Table 3.

Table 3: Construction noise levels for activities sensitive to noise[1] (e.g. occupied dwellings)

Time of week	Time period	Long-term duration[2]	
		dB L_{Aeq}	L_{AFmax}
Weekdays	0630 – 0730	55	75
	0730 – 1800	70	85
Saturdays	0730 – 1800	70	85
	1800 – 0630	45	75

3.2 Vibration – Cosmetic Building Damage

Condition X (refer Section X) and/or AUP rule E25.6.30 (1)(a) requires construction vibration to be measured and assessed in accordance with German Standard DIN 4150-3:1999 "*Structural vibration – Part 3: Effects of vibration on structures*". The short-term (transient)[3] vibration limits in Figure 1 apply at building foundations in any axis. The vibration limits in all other cases are summarised in Table 4.

[1] Activities sensitive to noise are defined as '*Any dwelling, visitor accommodations, boarding house, marae, Papakainga, integrated residential development, retirement village, supported residential care, care centres, lecture theatres in tertiary education facilities, classrooms in education facilities and healthcare facilities with an overnight stay facility*'.

[2] Construction work at any one location with a duration exceeding 20 weeks

[3] Short-term (transient) vibration is "*vibration which does not occur often enough to cause structural fatigue and which does not produce resonance in the structure being evaluated*"

Figure 1: Short-term (transient)[1] vibration at building foundations (DIN 4150-3 1999: Figure 1)

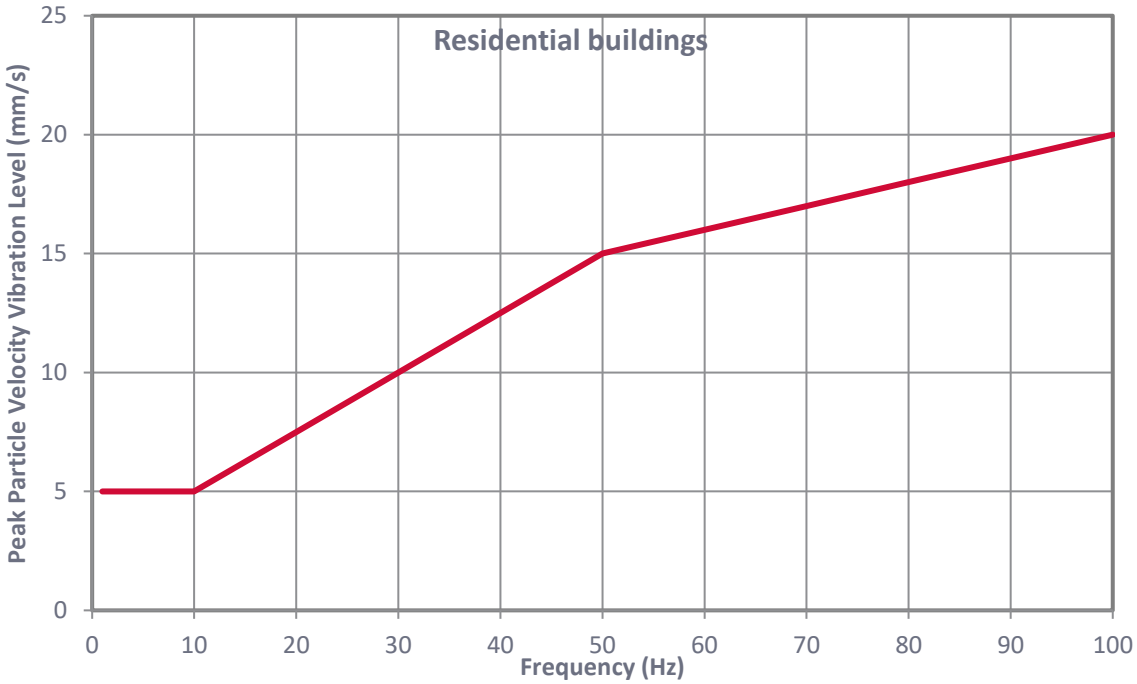


Table 4: Vibration at horizontal plane of highest floor (DIN 4150-3 1999: Tables 1 and 3)

Structure Type	Peak Particle Velocity Vibration Level (mm/s)	
	Short-term (transient)[1]	Long-term (continuous)[4, 5]
Residential buildings	15	5

The criteria relate to the avoidance of cosmetic building damage, such as cracking in paint or plasterwork. Cosmetic building damage effects are deemed 'minor damage' in the Standard and can generally be easily repaired. The cosmetic building damage thresholds are much lower than those that would result in structural damage. The Standard states: "*Experience has shown that if these values are complied with, damage that reduces the serviceability of the building will not occur*."

3.3 Vibration – Amenity

While the primary vibration concern is cosmetic building damage, people may be disturbed at levels significantly below the limits for cosmetic building damage in Section 3.2. British Standard BS 5228-2:2009 "*Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration*" provides the following guidance on the amenity effects of vibration:

- 0.14mm/s PPV Just perceptible in the particularly sensitive environments
- 0.3 mm/s PPV Just perceptible in normal residential environments
- 1 mm/s PPV Typically acceptable with prior notification
- 10 mm/s PPV Likely to be intolerable for any more than a very brief period

[4] Long-term (continuous) vibration includes types not covered by the short-term vibration definition

[5] The long-term (continuous) criteria can apply at all floor levels, but levels are normally highest at the top floor

Condition X in Section X or AUP Rule E25.6.30 (1)(b) requires construction vibration to comply with the limits in Table 5 in any axis when measured in the corner of the floor of the storey of interest for multi-storey buildings, or within 500mm of ground level at the foundation of a single storey building.

Table 5: Vibration amenity at horizontal plane of floor level of interest (AUP OIP E25.6.30.1)

Receiver	Peak Particle Velocity Vibration Level (mm/s)	
	0700 - 2200	2200 - 0700
Occupied activity sensitive to noise	2	0.3
Other occupied buildings	2	2

Where construction vibration from daytime works (7am to 6pm) is predicted to exceed 2mm/s PPV for no more than three days, the occupants of all buildings within 50m must be advised of the works no less than 3 days prior to the works commencing and the vibration level must not exceed 5mm/s (Section 6.1).

4.0 PREDICTED LEVELS

4.1 Noise

Table 6 provides indicative construction noise levels for proposed activities. It should be used by the Project Manager (or nominated person) prior to construction to inform what equipment will require mitigation and/or management and when. It should be kept up to date by the Acoustic Specialist when new information becomes apparent through noise monitoring (Section 7.1) or other means.

Table 6: Indicative noise levels at 1m from a building façade[6] no mitigation

Equipment	Sound Power (dB L_{WA})	Façade Noise Level (dB L_{Aeq})				Setback distance (m)
		5	10	15	20	
Vibratory sheet piling	116	97	91	85	76	83
Plate compactor	108	89	83	77	68	40
Grinder (hand tools)	108	89	83	77	68	40
Loader	107	88	82	76	67	36
Hydrovac excavation	107	88	82	76	67	36
Excavator (30T)	105	86	80	74	65	30
Directional drilling	105	86	80	74	65	30
Auger piling rig	103	84	78	72	63	25
Excavator (20T)	103	84	78	72	63	25
Concrete truck and pump	103	84	78	72	63	25
Static or vibratory roller	103	84	78	72	63	25
Excavator (5T)	102	83	77	71	62	22
Mobile Crane (35T) operating	98	79	73	67	58	14
Hydraulic power pack	97	78	72	66	57	13

[6] In accordance with the requirements of NZS 6803: 1999 (Section 3.1), inclusive of 3 decibels façade reflection

Equipment	Sound Power (dB L_{WA})	Façade Noise Level (dB L_{Aeq})				Setback distance (m)
		5	10	15	20	
Generator (150kVA)	93	74	68	62	53	8
Pump (150mm dia)	93	74	68	62	53	8
Compressor	93	74	68	62	53	8
Truck Idling	91	72	66	60	51	6
Mobile Crane (35T) idling	88	69	63	57	48	4

4.2 Vibration

Table 7 provides indicative construction vibration levels for proposed activities that have the potential to result in vibration in building structures. It should be used by the Project Manager (or nominated person) prior to construction to inform what equipment will require mitigation and/or management and when. It should be kept up to date by the Acoustic Specialist when new information becomes apparent through vibration monitoring (Section 7.2) or other means.

Table 7: Indicative distances to comply with vibration limits at building foundations

	Emission Radius (m)	
Vibration Source	Cosmetic Damage 5mm/s	Daytime Amenity 2mm/s*
Sheet piling	11	30
Vibratory roller	14	38

While the primary vibration concern is typically cosmetic building damage (Section 3.2), people may be disturbed at levels significantly lower levels (Section 3.3). Potentially affected parties should be informed about the vibration levels they may experience and assured vibration damage can only occur at magnitudes well above the threshold of perception (Section 6.1).

There are no receivers within 30m of a sheet piling location.

5.0 MITIGATION AND MANAGEMENT

5.1 Training

All staff will participate in an induction training session prior to the start of construction, with attention given to the following matters:

- Construction noise and vibration limits (Section 3.0)
- Activities with the potential to generate high levels of noise and/or vibration (Section 4.0)
- Noise and vibration mitigation and management procedures (Section 5.0)
- The sensitivity of receivers and any operational requirements and constraints identified through communication and consultation (Section 6.0)

Awareness of current noise and vibration matters on, or near active worksites, will be addressed during regular site meetings and/or 'toolbox' training sessions.

5.2 Equipment Selection

When selecting construction equipment, where practicable:

- Prioritise quieter construction methodologies

- Prioritise electric motors over diesel engines
- Prioritise rubber tracked equipment over steel tracked equipment
- Equipment should be suitably sized for the proposed task
- Equipment should be maintained and fitted with exhaust silencers and engine covers
- Avoid tonal reversing or warning alarms (suitable alternatives may include flashing lights, broadband audible alarms or reversing cameras inside vehicles)

5.3 General Measures

Complaints can arise whether or not noise and vibration levels comply with the Project limits. To avoid complaints, general mitigation and management measures include, but are not be limited to, the following:

- Avoid unnecessary noise, such as shouting, the use of horns, loud site radios, rough handling of material and equipment, and banging or shaking excavator buckets
- Avoid steel on steel contact such as during the loading of scaffolding on trucks
- Avoid high engine revs through appropriate equipment selection and turn engines off when idle
- Maintain site accessways to avoid potholes and corrugations
- Mitigate track squeal from tracked equipment, such as excavators (may include tensioning and watering or lubricating the tracks regularly)
- Minimise construction duration near sensitive receivers
- Stationary equipment (e.g. generators) should be located away from noise sensitive receivers and site buildings and material stores used to screen them
- Orient mobile machinery to maximise the distance between the engine exhaust and the nearest sensitive building façade (e.g. excavators)
- Utilise noise barriers where appropriate (Section 5.4)
- Implement specialised mitigation measures for piling (Section 5.5), vibratory rollers (Section 5.6)
- Ensure advanced communication is complete (Section 6.0) prior to commencing activities that are predicted to exceed the noise and vibration performance standards (Section 4.0)
- Undertake monitoring as appropriate (Section 7.0)

5.4 Noise Barriers

5.4.1 Temporary Noise Barriers

Temporary noise barriers should be used where a construction noise limit is predicted to be exceeded (Section 4.1) and the barriers would noticeably reduce the construction noise level. They should be installed prior to works commencing and maintained throughout the works. Effective noise barriers typically reduce the received noise level by 10 decibels.

Where practicable, the following guidelines should be incorporated in the design and utilisation of temporary noise barriers:

- The panels should be constructed from materials with a minimum surface mass of 6.5 kg/m^2. Suitable panels include 12 mm plywood or the following proprietary ‘noise curtains’:
  - Duraflex ‘Noise Control Barrier - Performance Series’ (www.duraflex.co.nz)
  - Soundex ‘Acoustic Curtain - Performance Series' (www.ultimate-solutions.co.nz)

- Flexshield 'Sonic Curtain with 4 kg/m^2 mass loaded vinyl backing' (www.flexshield.co.nz)
- Alternatives should be approved by a suitably qualified acoustic specialist because some proprietary noise curtains have insufficient surface mass for general use

- The panels should be a minimum height of 2.4m, and higher if practicable to block line-of-sight
- The panels should be abutted or overlapped to provide a continuous screen without gaps at the bottom or sides of the panels
- The panels should be positioned as close as practicable to the noisy construction activity to block line-of-sight between the activity and noise sensitive receivers

Where positioned on the site boundary, additional local barriers should be considered near the activity to ensure effective mitigation for sensitive receivers on upper floor levels.

5.4.2 Permanent Noise Barriers

Permanent boundary fences may be constructed, or existing fences upgraded, to provide effective noise mitigation during construction. However, where required for mitigating noise from future activities (post construction), the panels must be constructed from materials with a minimum surface mass of 10 kg/m^2, such as 18 mm plywood or 20 mm pine. Other guidelines for the design and utilisation of barriers are the same as those in Section 5.4.1.

5.5 Piling

Where practicable:

- Prioritise piling methods that minimise noise and vibration (e.g. augured, screw or press-in piles over impact driven or vibratory piling methods)
- Avoid alternating rotation of the bored piling auger to loosen spoil into the muck bin. Shaking the kelly bit connection creates very loud banging that can result in noise complaints. It is understood this action can be avoided for general auger use, but is necessary specifically when a coring barrel is used to drill through obstructions (due to Health and Safety issues related to alternative ways of loosening material from the bit).
- Use a non-metallic 'dolly' or 'cushion cap' between the impact piling hammer and the driving helmet (e.g. plastic or plywood)
- Use an enclosed impact piling driving system that shrouds the point of impact

5.6 Vibratory Roller

For vibratory roller activities:

- Prioritise the use of static rollers over vibratory rollers, or switch off the vibration function within predicted safe setback distances (Section 4.2)
- Match the size of roller to the scale of the works (i.e. large enough to undertake the works efficiently, but avoiding oversized units)
- Match the vibration output to the scale of the works (i.e. combination of minimising the amplitude of the drum vibration and/or maximising the vibration frequency of operation)

6.0 ENGAGEMENT

6.1 Communication

Written communication (e.g. newsletter) should be provided to occupiers of buildings within 50 m of the site at least 1 week prior to the Project commencing. It should acknowledge that some activities are predicted to generate high noise and/or vibration levels that may result in disturbance for short

periods. It should include details of the overall works, its timing, duration and contact details where complaints and enquiries should be directed.

Written communication during the works:

- Public site signage should include contact details
- Regular project updates should include details of impending activities that may result in disturbance, including piling (Section 5.5), vibratory rollers (Section 5.6). It should include scheduled timing and duration of these activities and contact details where complaints and enquiries should be directed.
- Occupants of buildings predicted to receive vibration levels exceeding 2mm/s PPV for more than three days should be advised at least 3 days prior to the works commencing (Section 3.3)

6.2 Consultation

Consultation should be undertaken to address reasonable concerns about noise and vibration on a case-by-case basis. The Project Manager should address any concerns and complaints in accordance with Section 6.3. When discussing vibration concerns, it is important to convey that vibration can be felt at levels well below those that pose a risk of cosmetic building damage. A copy of all correspondence should be made available to Council upon request.

The following process will be implemented by the Project Manager (or nominated person). It is for any construction activity measured to exceed the relevant construction noise and vibration performance standards:

- For exceedances of the construction vibration standards, activities should cease as soon as safe and practicable to do so
- Review the construction methodology, mitigation measures and management strategies to ensure they represent the BPO. This should consider affected parties' interests, practicability and material benefit of further measures, and implications to Project timing, duration and cost
- Undertake consultation with affected parties to understand their sensitivities, including times, activities and locations. Consultation should focus on a collaborative approach to managing the adverse effects from construction noise and vibration. A project representative should be contactable during works. A record of consultation should be kept at the site office and be available to the affected parties and Council if requested.
- Implement measures to avoid significant adverse effects as agreed with the affected party and monitor the activity to verify the extent of any adverse effects
- For exceedances of the construction vibration cosmetic building damage thresholds in Section 3.2, a detailed building condition survey will be undertaken in accordance with Section 7.3. If damage has not occurred, then that activity can continue provided the measured vibration level is not exceeded further and the construction methodology is the BPO. If damage has occurred, alternative construction methods should be investigated, and the consent holder should commit to repairing the damage within a reasonable timeframe.
- The installation of mechanical ventilation should be considered for noise sensitive receivers where external windows must be closed to avoid significant adverse noise effects and no alternative ventilation system is present. This will be implemented only after all other general noise management and mitigation have been deemed impracticable.
- Temporary relocation should be considered for sensitive receivers where all practicable noise and vibration management and mitigation measures have been implemented and significant adverse noise effects are predicted. This will be in exceptional cases only, and advice from the Acoustic Specialist will be sought prior.

6.3 Complaints Response

All construction noise and/or vibration complaints should be recorded in a complaints file that is available to Council on request. For each complaint, an investigation should be undertaken involving the following steps as soon as practicable:

- Acknowledge receipt of the concern or complaint within 24 hours and record:
  - Time and date the complaint was received and who received it
  - Time and date of the activity subject to the complaint (estimated where not known)
  - The name, address and contact details of the complainant (unless they elect not to provide)
  - The complainant's description of the activity and its resulting effects
  - Any relief sought by the complainant (e.g. scheduling of the activity)
- Identify the relevant activity and the nature of the works at the time of the complaint
- If a reasonable complaint relates to building damage, inform the on-duty site manager as soon as practicable and cease associated works pending an investigation.
- Review the activity noise and/or vibration levels (Section 4.0) to determine if the activity is predicted to comply with the relevant performance standards (Section 3.0) at the complainants building. Consider addended monitoring to verify the underlying reference level assumptions.
- Review the mitigation and management measures in to ensure the activity represents the BPO (Section 5.0). Review the relief sought by the complainant. Adopt further mitigation and management measures as appropriate.
- Review the potential residual effects (Section 4.0) of activities that are predicted to exceed the relevant performance standards (Section 3.0)
- Report the findings and recommendations to the Project Manager, implement changes and update this CNVMP as appropriate
- Report the outcomes of the investigation to the complainant, identifying where the relief sought by the complainant has been adopted or the reason(s) otherwise.

In most cases, ceasing the activity would provide immediate relief. In some cases, this may not be practicable for safety or other reasons. The complainant shall be kept updated regularly during the time it takes to resolve the matter.

7.0 MONITORING

7.1 Noise

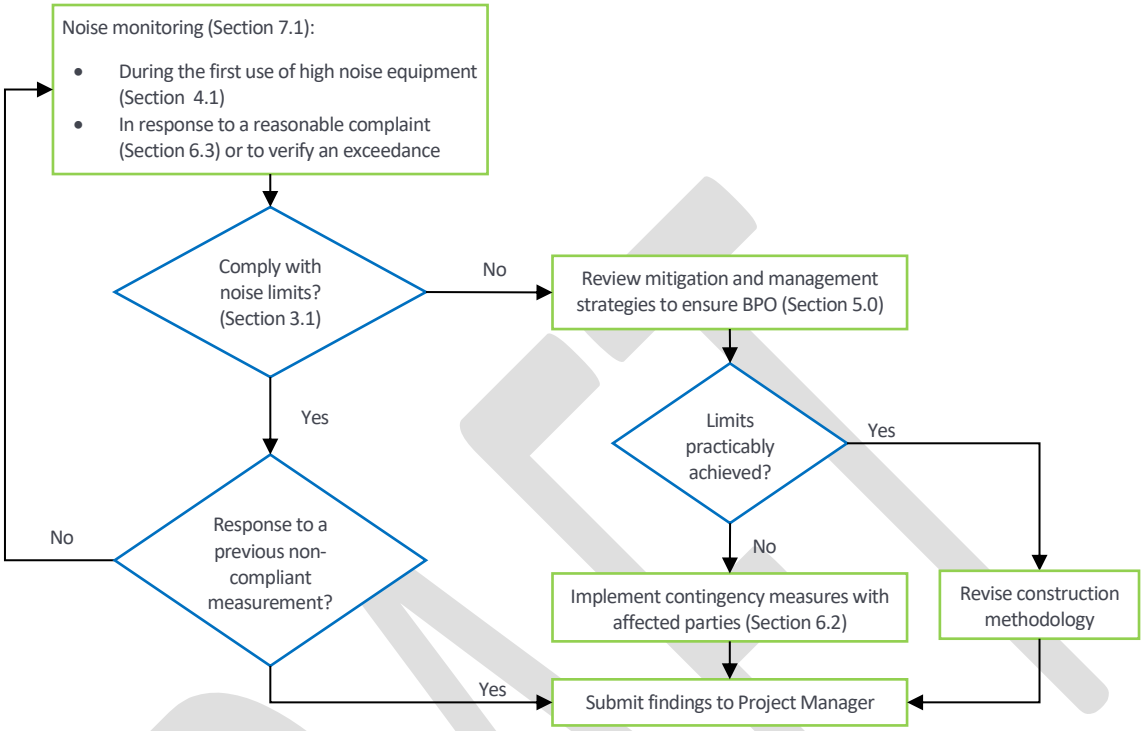
Construction noise levels should be monitored:

- During the first occurrence of vibro piling, or other activities that are predicted to exceed the noise limits (Section 4.1), and
- In response to a reasonable noise complaint (Section 6.3)
- At 1m from the most affected building façade, or proxy position and adjusted for distance and façade reflections where appropriate
- By a suitably qualified and experienced specialist (e.g. Member of the Acoustical Society of New Zealand) in accordance with the requirements of New Zealand Standard NZS 6803: 1999 *"Acoustics - Construction Noise"*
- For a representative duration, reported with the measured level (e.g. 65 dB $L_{Aeq\,(30min)}$)

- The results should be used to update Section 4.1 if appropriate

A noise monitoring flowchart is presented in Figure 2.

Figure 2: Noise Monitoring Flow Chart



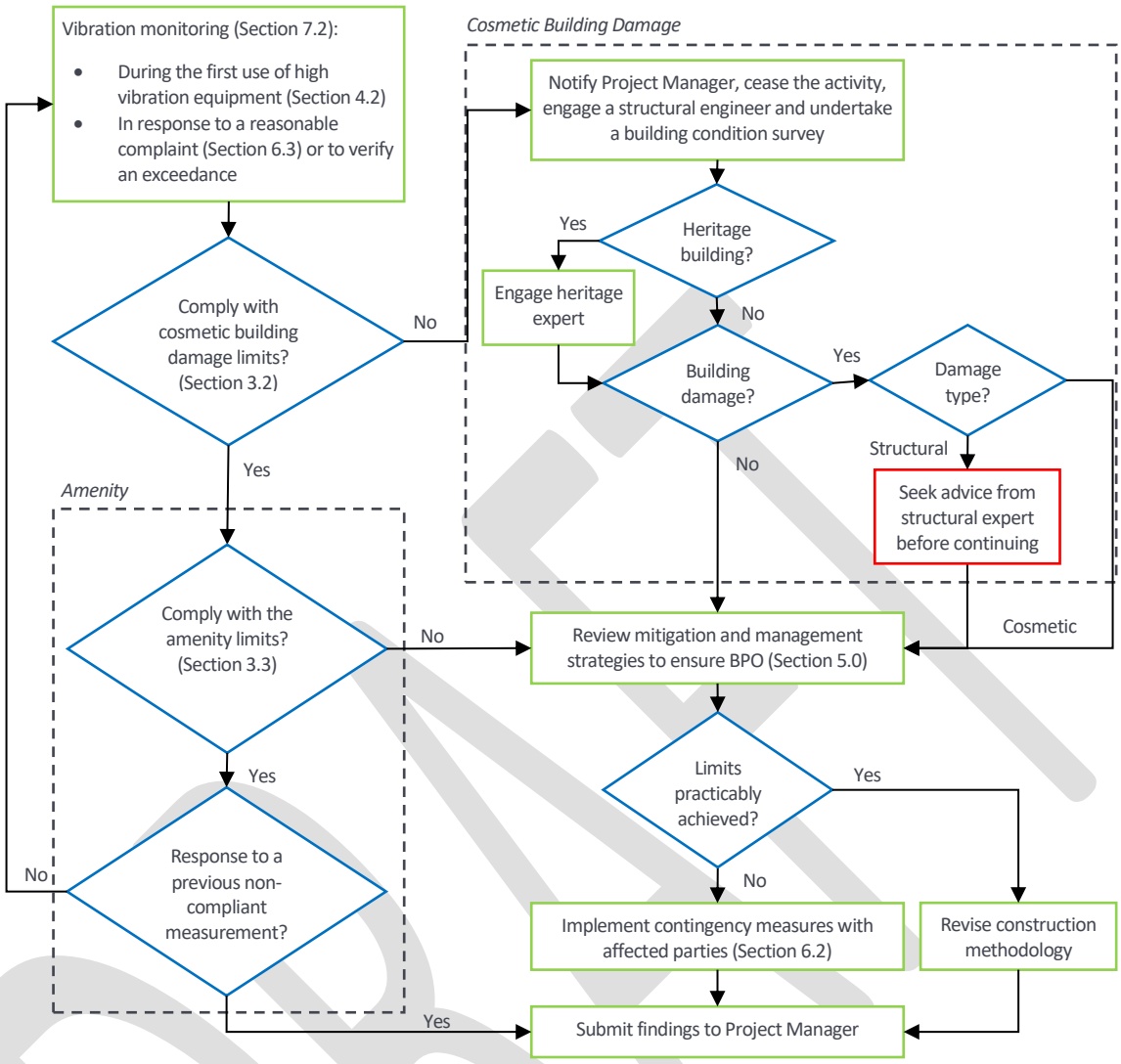
7.2 Vibration

Construction vibration should be monitored:

- During the first occurrence of vibratory rolling that is predicted to exceed the vibration limits (Section 4.2) and following the completion of pre-construction building condition surveys (Section 7.3)
- In response to a reasonable vibration complaint (Section 6.3)
- At the closest building foundations and/or the top floor level as appropriate where consent to access the building of interest has been requested and granted
- By a suitably qualified and experienced specialist (e.g. Member of the Acoustical Society of New Zealand) in accordance the requirements of German Standard DIN 4150-3:1999 "*Structural vibration – Part 3: Effects of vibration on structures*"
- For a representative construction duration, measured in 2 second intervals
- The results should be used to update Section 4.2 if appropriate

A vibration monitoring flowchart is presented in Figure 3.

Figure 3: Vibration Monitoring Flow Chart



7.3 Building Condition Surveys

Cosmetic building damage (e.g. plaster or paint cracking) is an effect that is relevant to the building owner only (i.e. rather than tenants or leaseholders). People generally perceive vibration at levels significantly lower than those levels that would result in cosmetic building damage and an understanding of this often alleviates receivers' concerns.

A condition survey should be undertaken for the buildings within 14m of a vibratory rolling location.

The Project Manager should request in writing the approval of the property owner to undertake a building condition survey at the following times:

- Prior to construction commencing where vibration is predicted to exceed the cosmetic building damage limits (Section 4.2)
- During construction, where vibration is measured to exceed the cosmetic building damage limits in (Section 4.2) and/or in response to a reasonable claim of damage from construction vibration (Section 6.3)
- Post construction to avoid subsequent claims of damage from construction vibration (Section 6.3)

If a vibration exceedance has occurred but there is no resulting cosmetic damage, then that activity can continue provided the measured vibration level is not exceeded further and the construction

methodology already adheres to the BPO. If damage has occurred, alternative construction methods should be investigated and the Contractor should rectify the damage at its own cost, as soon as practicable, in consultation with the owner of the property.

Each building condition survey should:

- Be undertaken by a suitably qualified person
- Provide a description of the building
- Determine the appropriate structure type classification[7] with respect to DIN 4150-3:1999 *"Structural Vibration - Effects of Vibration on Structures"* (i.e. historic/sensitive, residential or commercial/industrial)
- Document and photograph the condition of the building, including any cosmetic and/or structural damage
- The results should be provided to the property owner and be available to Council on request

[7] Classifications with respect to Tables 1 and 3 of DIN 4150-3:1999 *"Structural Vibration - Effects of Vibration on Structures"* (i.e. historic/sensitive, residential or commercial/industrial)

APPENDIX A GLOSSARY OF TERMINOLOGY

Noise	A sound that is unwanted by, or distracting to, the receiver.
dB	Decibel (dB) is the unit of sound level. Expressed as a logarithmic ratio of sound pressure (P) relative to a reference pressure (Pr), where dB = 20 x log(P/Pr).
dBA	The unit of sound level which has its frequency characteristics modified by a filter (A-weighted) to more closely approximate the frequency bias of the human ear. A-weighting is used in airborne acoustics.
$L_{Aeq\ (t)}$	The equivalent continuous (time-averaged) A-weighted sound level commonly referred to as the average level. The suffix (t) represents the period, e.g. (8 h) would represent a period of 8 hours, (15 min) would represent a period of 15 minutes and (2200-0700) would represent a measurement time between 10 pm and 7 am.
L_{AFmax}	The A-weighted maximum noise level. The highest noise level which occurs during the measurement period.
NZS 6803:1999	New Zealand Standard NZS 6803: 1999 "Acoustics - Construction Noise"
Vibration	When an object vibrates, it moves rapidly up and down or from side to side. The magnitude of the sensation when feeling a vibrating object is related to the vibration velocity. Vibration can occur in any direction. When vibration velocities are described, it can be either the total vibration velocity, which includes all directions, or it can be separated into vertical (up and down vibration), horizontal transverse (side to side) and horizontal longitudinal direction (front to back) components.
PPV	Peak Particle Velocity (PPV) is the measure of the vibration amplitude, zero to maximum, measured in mm/s.
BS 5228:2009	British Standard BS 5228:2009 "Code of practice for noise and vibration control on construction and open sites, Part 1: Noise, Part 2: Vibration"
DIN 4150-3:1999	German Standard DIN 4150-3:1999 *"Structural Vibration - Effects of Vibration on Structures"*

APPENDIX B SITE

Figure 4: Site plan

Figure 5: Site zoning and nearby receivers